



Engineering Solutions- Introduction Due June 1st

Directions: For these last assignments, you will be introduced to the engineering design model. This first assignment will be an overview of the aspects of the design process. The second and third assignments will be a case study of Radcliffe Creek Ecosystem.

Part 1: Background

You will consider cause and effect relationships as the decisions you make have environmental consequences. You will also act as engineers. As engineers you will develop and use criteria to evaluate solutions to environmental problems. Finally, you will design your own solution to a problem.

Cause and effect relationship - Environmental Consequences

Problem:	Cause:	Effect/Impact:
Filling in a marsh for a new hotel		
Sediment Pollution from road construction		
Climate Change causing migration problems for birds		

Part 2: Develop and use criteria to evaluate solutions

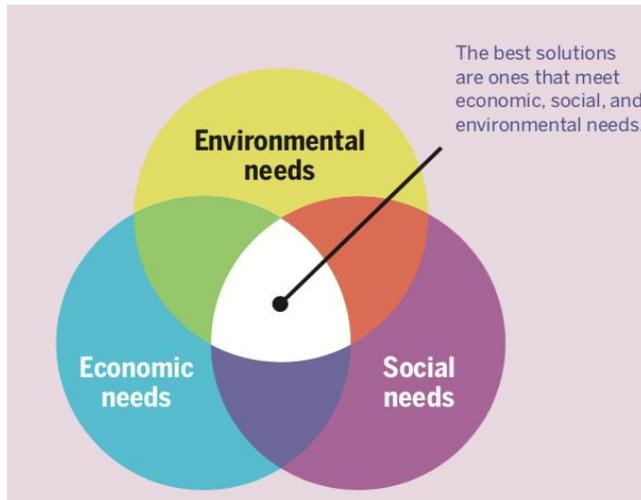
A good solution works for people and for the environment. It also does not create problems in the future. In this activity you will use a framework to examine and design solutions to environmental problems

Reading:

Engineers design solutions to problems. However, the aim of engineering is not just to design a solution, but to design the best solution. Before designing a solution, engineers will identify criteria and constraints. Criteria are the desired features of the solution. Constraints are limits that apply to solving the problem. Criteria can be a little more flexible. A solution can have many criteria and constraints. This can make designing the solution complicated. It can be difficult to satisfy the needs of people and those of the environment. When considering criteria related to people, it is useful to look at the social and economic impacts. Economic impacts are often related to money. They can be positive, such as earning more money. They can also be negative, such as reduced income or higher costs for people in an area. Social impacts are often related to the quality of life. They can include factors such as the health and safety of



residents, the standard of living, and opportunities for work and leisure. An important social consideration is whether a solution is fair to different groups of people. One way of analyzing solutions to environmental problems is to consider how well they meet economic, social, and environmental needs.



Designing, or deciding on, the best solution may require making trade-offs between criteria. A trade-off is when something that is a benefit or advantage is given up in return for a different benefit or advantage. For example, an environmental criterion might be to protect all of the land in an area. However, a social criterion might be to provide enough housing for the people living near the area. Since housing requires land, it would be difficult to meet both of these criteria. In such a case, a trade-off might mean that one of the criteria is selected over the other. In another case, maybe one or both of the criteria would need to be changed. With competing criteria, it is not unusual to have disagreements about what is the “best” solution to a problem.

Problem	Information(include the criteria and constraints)	Possible Solution
Chestertown is in need of more parking to accommodate tourists		
KCMS has decided to limit the amount of paper used on a daily basis. Teachers are now limited to only 100 copies per week.		
A local farm has been sold to a developer with intentions of building a new housing community		



Part 3: Design your own solution to problem

Problem: Chesapeake Bay is the largest estuary in the country. Over 100,000 rivers and streams from six states, including New York, drain into the bay. Over 16 million people live close to these streams and rivers. It used to be the world's largest oyster-producing region. However, this century the oyster harvest is only about 1% of what it was 100 years ago. The reasons for this large decline include destruction of habitat, overharvesting, disease, and reduction in water quality.

The decrease in oysters has had a major effect on the environment and the local economy. Without large numbers of oysters, the water in the bay is not filtered well. The water quality is made worse by runoff into the streams and rivers that feed into the bay. The runoff is rich in nutrients. This has increased algae growth in the bay. When the algae die, they sink to the bottom of the bay where bacteria decompose them. The presence of large numbers of bacteria reduces the oxygen content of the water, causing dead zones. Very few organisms can survive in these zones. Some of the organisms that are mobile, such as crabs and fish, can move out of the dead zone. Other organisms that cannot move as freely, such as oysters, are more likely to die in dead zones.

Possible Solution	How well it meets the needs of people	How will it meet the needs of the oysters
A. Ban the harvesting of oysters until the oyster population has recovered to what it was 100 years ago.		
B. Introduce a larger, fast-growing oyster from Asia that can filter the waters and can also be harvested and sold.		
C. Ban the use of substances such as fertilizer in communities close to the rivers and streams that drain into the bay.		
D. Install filtering systems at the mouths of the rivers and streams that drain into the bay.		
E. Retrain the people who rely on the oyster fishery to catch and sell other organisms, such as crabs, instead.		

1. Make a recommendation for the best solution. Explain why this was your choice.



Watershed Watch: Radcliffe Creek Solutions - Due June 6th

This year we have studied the health of Radcliffe Creek. The actions of those living or working in the watershed affect the quality of the water and the delicate balance of the ecosystem. Use the background review information at the end of the assignment to help you determine the meaning.

Type of Test	Fall Data	Meaning
pH	6.5	
Salinity	0.0 ppt	
Dissolved Oxygen	4.25 ppm	
Nitrates	2.5 ppm	
Phosphorus	1.0 ppm	

After watching the Sultana video, analyze the spring data:

Type of Test	Spring Data	Meaning
pH	6.5	
Salinity	0.0 ppt	
Dissolved Oxygen	3.75 ppm	
Nitrates	5.0 ppm	
Phosphorus	3.0 ppm	

Graph Nitrates

Use the data below to create a graph showing nitrate levels over time

Date	Level of Nitrates (ppm)
10/2018	2.5
2/2019	20.0
4/2019	5.0
8/2019	3.5
10/2019	3.0
11/2019	2.0
1/2020	1.25

Graph Dissolved Oxygen

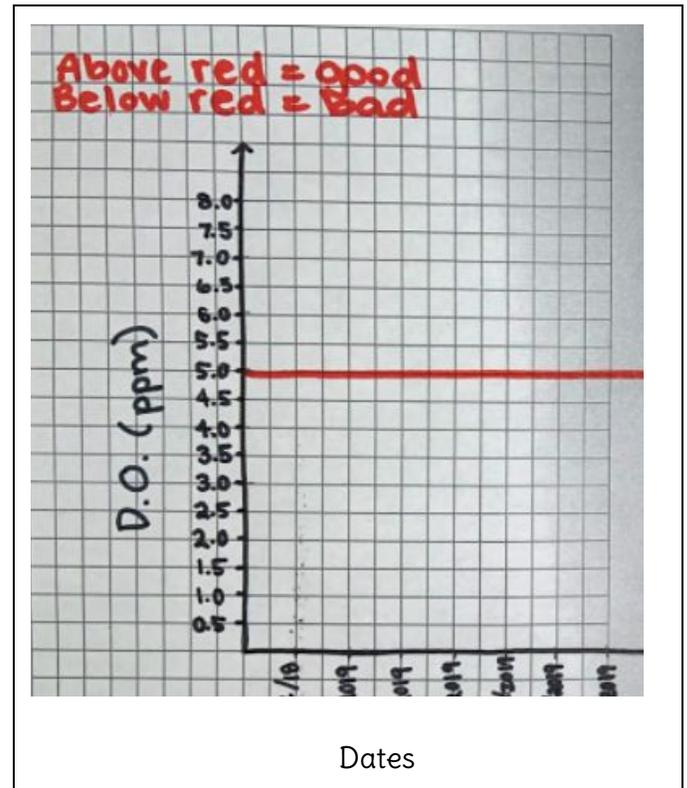
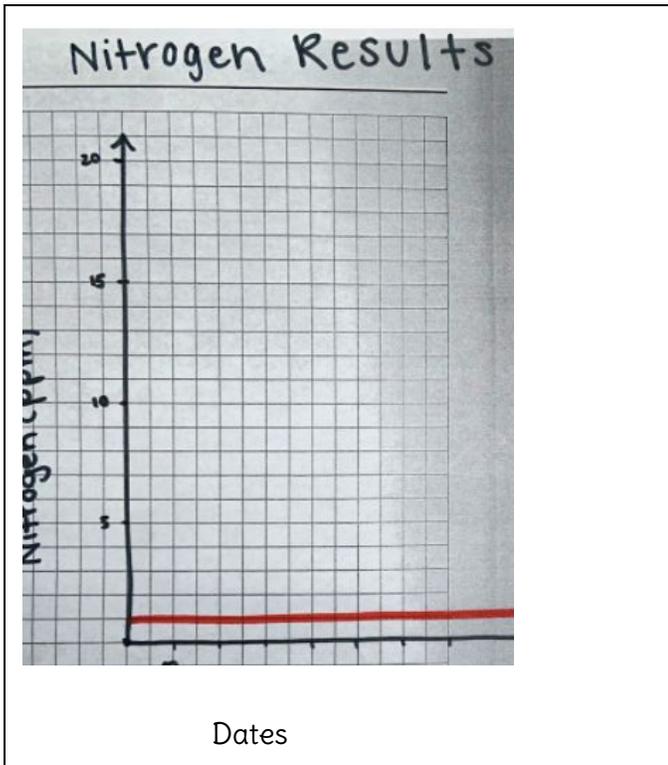
Use the data below to create a graph showing dissolved oxygen levels over time

Date	Level of Dissolved Oxygen (ppm)
10/2018	4.5
2/2019	4.0
4/2019	4.0
8/2019	3.0
10/2019	4.0
11/2019	2.0
1/2020	3.0



Graph of Nitrates (above red line bad, below red line good)

Graph of Dissolved Oxygen

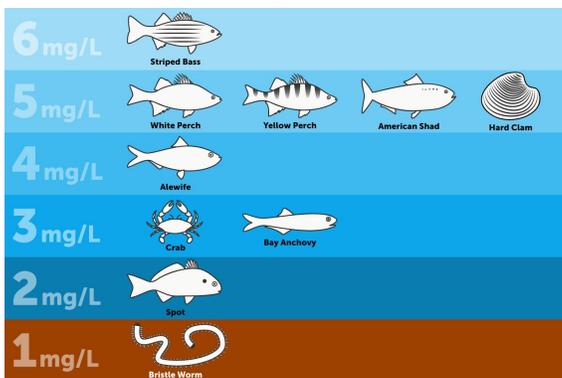


Wrap Up Questions:

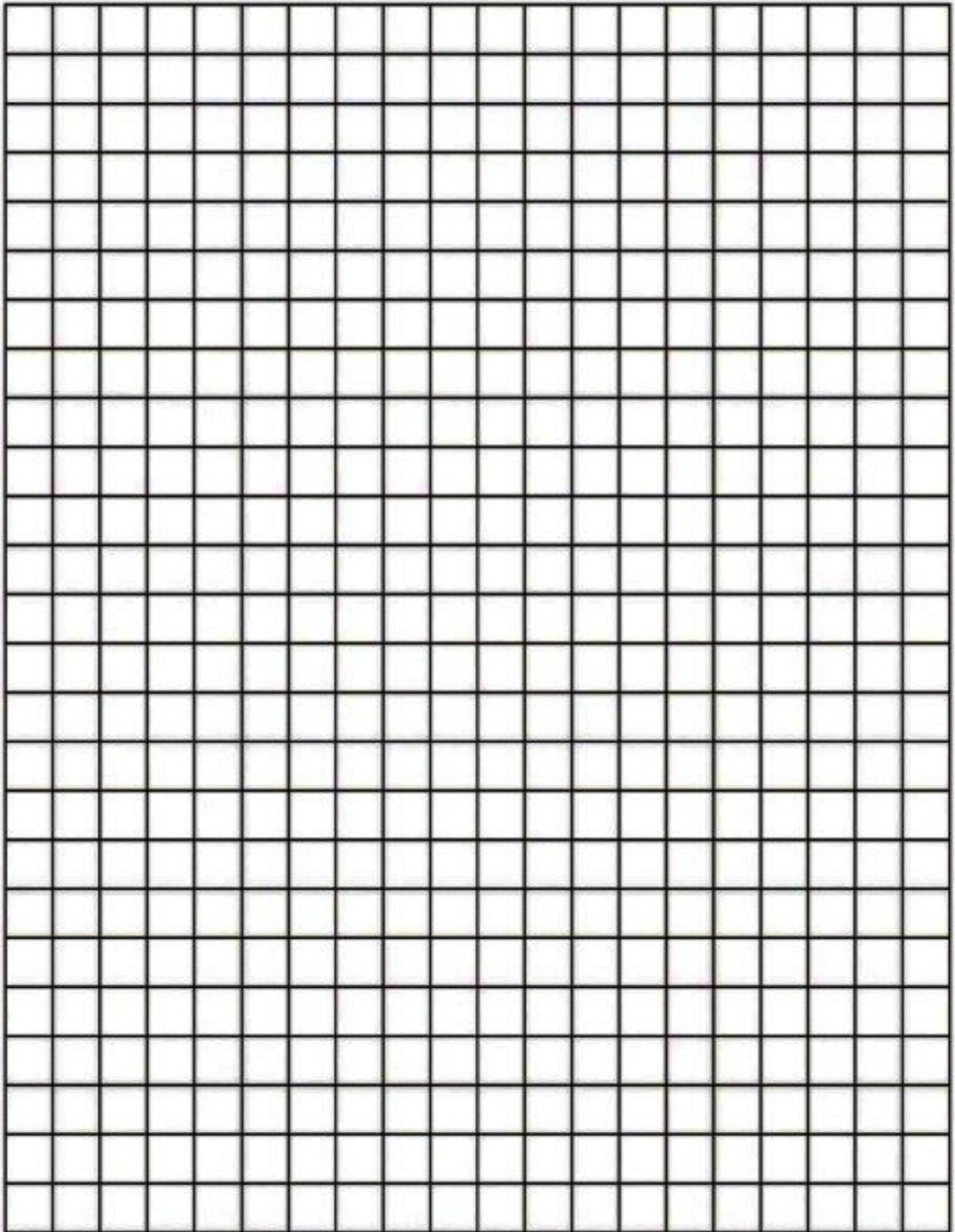
1. Above 1ppm is poor water quality for nitrates. Based on your data, what have you learned about the nitrate levels in Radcliffe Creek? Is this ecosystem healthy?
2. Below 5ppm is poor water quality for dissolved oxygen. Based on your data, what have you learned about the dissolved oxygen levels in Radcliffe Creek? Is this ecosystem healthy?

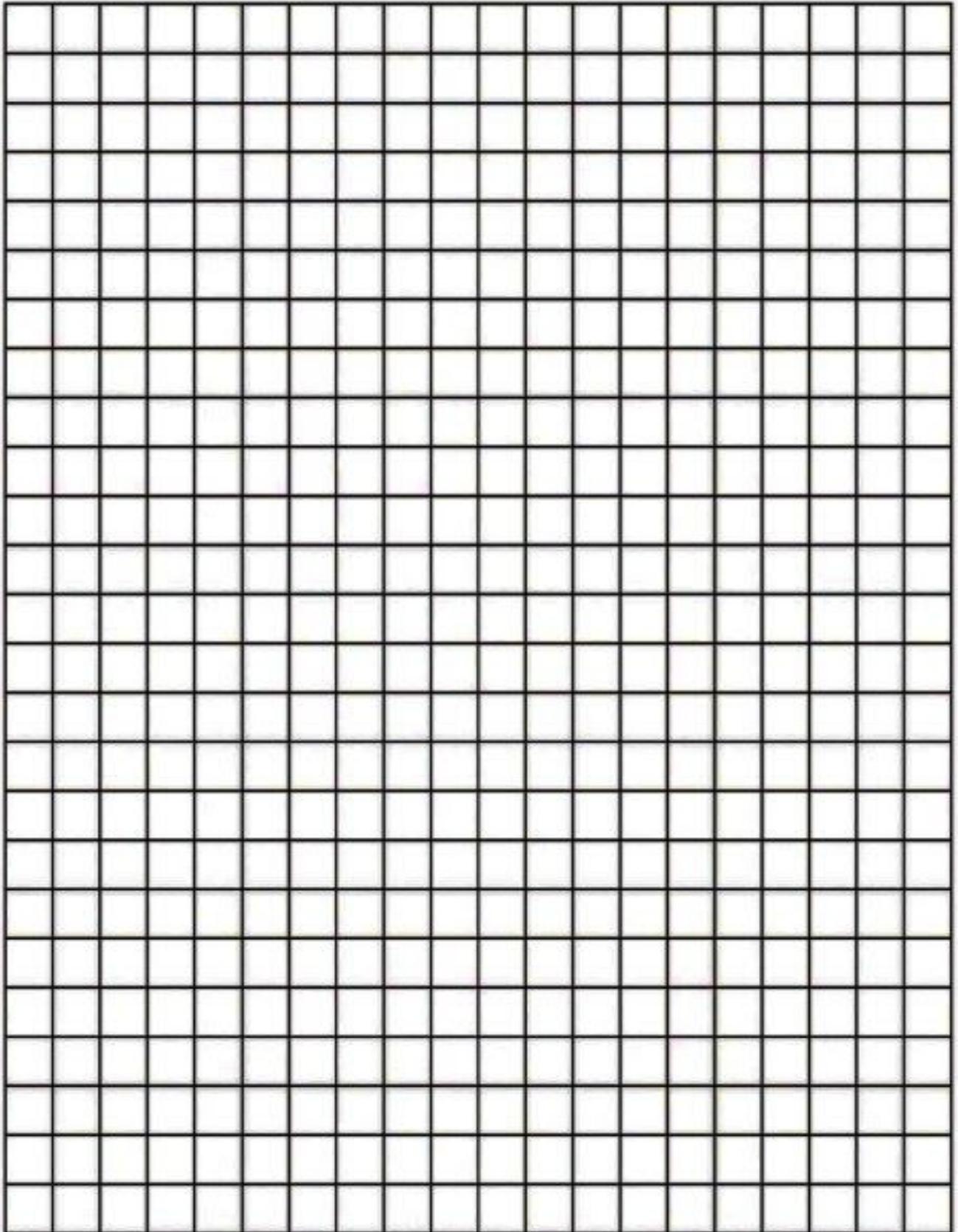
Background Review:

Dissolve Oxygen Ranges



Nitrates and Phosphorus over 1 or 2 ppm is high and will likely cause algal blooms. Neutral pH is 7 and plants and animals can live in a range from about 5 - 8. Salinity can range between 0 and 35 ppt. 35 ppt would be salt water and 0ppt would be fresh water.







Engineering Solutions: Focus on Radcliffe Creek Due June 12th

Directions: Now that you have a basic understanding of designing solutions and the engineering process, apply that information to the case study on Radcliffe Creek.

Part 1: Identifying the Issues - Guiding Question - How can the negative impact of humans on Radcliffe Creek be reduced?

Radcliffe Creek is a tributary of the Chester River that winds gently along the southern boundary of the town of Chestertown. The tidal portion of the creek is navigable by canoe or kayak for approximately one mile, entering the Chester just beyond the Quaker Neck Bridge on the Kent County side of the river.

Radcliffe Creek's watershed extends well into Chestertown. Land use within the drainage basin includes large scale commercial development, residential development, and agricultural land. Additional land cover includes marshes, swamps, forests, and non-tidal wetlands. This incredibly diverse ecosystem provides students with a unique opportunity to examine how land uses within a local watershed impact the water quality of natural systems downstream.

Part 2: Learn the issues/threats - Background and Data Analysis

Summarize your data from the previous assignment about the water quality for Radcliffe Creek.

Part 3: Designing a Solution

Brainstorm the causes to these problem and the effect or impact

Problem:	Cause:	Effect/Impact:
Too many nutrients from nitrogen pollution		
Limited biodiversity in the watershed		
Lack of underwater grasses		

Summarize one of these threats and why it is important to develop a solution.



Part 4: Evaluating Solutions

Design three possible options to stop or reduce the threats to Radcliffe Creek.

Choose your Problem - (pick from one above)	Information (what are the causes and effects, etc.)	Possible Solution
Option 1		
Option 2		
Option 3		

Part 5: Presentation Background - Choose one of your options to make your final solution

In your design, make sure to include the following:

The environmental, economic, and social aspects of your proposed solution.

The criteria and constraints that apply to your solution.

The evidence that you would need to see in order for you to feel that your solution had worked.



Part 6: Google Slides or Poster Presentation with information from Part 5. Use the following rubric to make sure you have all the information. (Science vocabulary, evidence from data, images, format)

Rubric:

Format (20 points)

__/5 Include scientific vocabulary

__/5 Correct spelling and grammar

__/10 Sources are cited

Content (80 points)

__/10 Title and description of your solution

__/20 3 pieces of evidence from data to support your solution

__/10 Colorful images (can be drawn or found on internet)

__/20 Steps on implementing your solution

__/20 Evaluation of your solution